



DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD
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7 8 JUL 2003

DDESB-KT

MEMORANDUM FOR HEADQUARTERS AIR FORCE SAFETY CENTER
(ATTENTION: SEW)

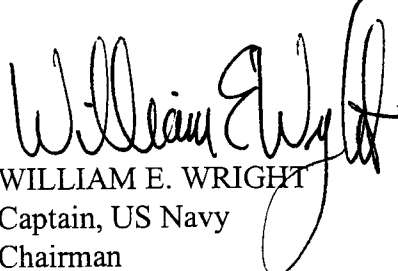
SUBJECT: Rationale for Noble Eagle Maximum Credible Events (MCEs)

References: (a) HQ AFSC/SEW Memorandum of 11 June 2003, Subject as above

(b) DDESB-IK Memorandum of 2 July 2002, subject: Approval of Proposed Noble Eagle Maximum Credible Events and Related Quantity Distance

Reference (a), with its attachments, fulfills the rationale and testing documentation requested as part of the Noble Eagle approval provided by reference (b).

Point of Contact for this action is Mr. Eric Deschambault, commercial phone: 703-325-1369; DSN: 221-1369; fax: 703-325-6227; and e-mail: Eric.Deschambault@ddesb.osd.mil.


WILLIAM E. WRIGHT
Captain, US Navy
Chairman



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE SAFETY CENTER

11 JUN 2003

MEMORANDUM FOR DDESB-IK

FROM: HQ AFSC/SEW
9700 G Avenue, SE
Kirtland AFB NM 87117-5670

SUBJECT: Rationale for Noble Eagle Maximum Credible Events (MCEs)

References:

a. Memorandum, DDESB-IK, 2 July 2002, Subject: Approval of Proposed Noble Eagle Maximum Credible Events and Related Quantity Distance.

b. Email, 28 June 2002, from Mr. Eric Olson (AFSC/SEWEW), Subject: Request for DDESB Approval of Noble Eagle Aircraft QD, with attachment: Quantity Distance Determinations Resulting from Noble Eagle Testing Program.

Reference a conveyed DDESB approval of the Noble Eagle QD criteria tabulated in reference b. Reference a also requested that DDESB be provided with certain documentation of the testing and rationale that were not included with reference b. This memorandum is in response to that request.

The documentation is voluminous and is forwarded on the two attached CDs. The first CD includes a file labeled as a "rationale attachment." That document explains the rationale and makes reference to the various test reports, analyses, and other documents also included in folders on the first CD. The second CD includes extensive photographic records and pressure data.

My POC is Mr. Eric Olson, Deputy, Weapons Safety Division, DSN 246-5658.

DANIEL T. TOMPKINS, Colonel, USAF
Chief, Weapons Safety Division

Attachment:

CD – Rationale, Test Reports, and Analyses
CD – Photos and Pressure Data

RATIONALE FOR NOBLE EAGLE MAXIMUM CREDIBLE EVENTS (MCES)

References:

- a. Email, 28 June 2002, from Mr. Eric Olson (AFSC/SEWEW), Subject: Request for DDESB Approval of Noble Eagle Aircraft QD, with attachment: Quantity Distance Determinations Resulting from Noble Eagle Testing Program
- b. Memorandum, DDESB-IK, 2 July 2002, Subject: Approval of Proposed Noble Eagle Maximum Credible Events and Related Quantity Distance.
- c. Defense Threat Reduction Agency (DTRA) Test Report, ARA-LR-4.04-001, February 1999, AIM-120 Warhead Characterization Test
- d. DTRA Test Report, ARA-LR-4.04-002, July 1999, AIM-120 Test 3 – Multiple Acceptor Test
- e. DTRA Test Report, ARA-LR-4.04-003, April 2000, AIM-120 Test 4 – Acceptor Response Test
- f. DTRA Test Report, ARA-LR-4.04-005, April 2001, AIM-120 Phenomenology Test 6
- g. Memorandum, 46 OG/OGM, (signed on or before 18 July 2002), Subject: AAC Letter Report 02-46, Maximum Credible Event Testing of Air Defense Weapon Loads, JON AFZE0025
- h. Letter, IHD, NSWC, Ser 440E/141(02), 28 June 2002, Noble Eagle Fragment/Debris Estimates

Reference a requested DDESB approval of Maximum Credible Events (MCEs) and associated Quantity Distance (QD) requirements for various air-to-air missile load configurations on F-15 and F-16 aircraft, in the open and in fabric as well as light metal structures. It also indicated a one-missile MCE for AIM-120 missiles loaded in a single layer, in alternating directions on a trailer. The attachment to Reference a provided the explanation of the QD criteria based on the MCEs, on previously established warhead fragment distances of record, on two new warhead fragment distances based on an IHD, NSWC analysis, and on an analysis of the fabric and light metal structures. The attachment to Reference a accompanies this statement. The test data and geometry analyses that established the MCEs, the analyses of the two new warhead distances and the structure analyses were not documented in the attachment to reference a, but had been

evaluated in a meeting, 20 June 2002, at DDESB pursuant to expediting the approval in order to support time-critical Noble Eagle site plans. DDESB was separately provided with scaled aircraft/weapon load drawings to support that evaluation. The drawings are referred to in this statement of rationale. The attachment to reference a is included on a CD with this statement.

Reference b conveyed DDESB approval of the Noble Eagle QD criteria and requested that DDESB be provided with the documentation of the testing and rationale that were not included with reference a. This statement includes the rationale, and is accompanied on a CD with the pertinent test reports and analyses. References c through h are included on the CD. Note: Reference g was received by AFSC/SEW via email, dated 18 July 2002, which stated the test report had been signed at 46 OG/OGM.

Several conclusions that supported the approval were derived from references c through h, as follows:

a. References c through e document three AIM-120 warhead (WDU-33) tests in which four acceptor warheads were penetrated by donor warhead fragments, but did not detonate. The mutual orientation and spacing of the warheads represented the worst-case pair on an F-16. In the last test, the acceptor warhead was canted to experience normal impact (not possible on the actual load configuration) to replicate exposure of an internally instrumented warhead, for the purpose of providing data to improve modeling and simulation of sympathetic detonation. *This testing showed that the MCE for an F-16 loaded solely with AIM-120s (with WDU-33 warheads) is detonation of one warhead.* The NEWQD for that event includes a small motor contribution established by earlier hazard classification testing and is listed in the Joint Hazard Classification System (JHCS) database.

b. Reference f reports testing of WDU-33 (AIM-120) warheads and motors in a trailer-load configuration having alternating missile directions. Acceptor warhead detonation did not occur, and there was no significant motor contribution. *This testing supports a one-missile MCE if the trailer load is limited to a single layer of AIM-120s (with WDU-33 warheads) having alternating missile directions.* (In multiple layers, alternating the missile directions does not preclude radial alignment of warheads between layers). Follow-on testing with WAU-17 donor warheads and WDU-41 acceptors shows this approach is also valid for alternated AIM-120 missiles with WDU-41 warheads in a single layer. A report of the follow-on testing accompanies this statement.

c. Reference g reports testing of four warhead types (WAU-17 for AIM-7, WAU-10 for AIM-7, WDU-33 for AIM-120, and WDU-41 for AIM-120) that can be loaded on the fuselage stations of an F-15. The fuselage does not completely interrupt line of sight between like warheads on either side, where the warheads are in or nearly in radial alignment. Three test iterations were conducted for each warhead type, with two acceptors at 100 inches from a donor that was detonated. In no case did an acceptor detonate high order. WAU-17 acceptors partially reacted in a manner that produced several large warhead pieces, but substantial unreacted explosive fill was also recovered

from each warhead. *This testing showed that a warhead detonation will not cause sympathetic detonation of a warhead on the opposite wing of an F-15 loaded with air-to-air missiles.* Earlier testing of MK-84 bombs on F-16s had also shown that the fuselage and fuel tanks provide an acceptor bomb with fragment protection from a donor bomb detonation on the opposite wing. *That MK-84 testing, in combination with the line-of-sight testing at 100 inches showed that a warhead detonation on an F-16 will not cause detonation of a warhead on the opposite wing.* (The closest weapon stations on an F-16 on opposite wings are much further apart.)

d. Reference g also reports testing of a worst-case lateral exposure of a MK-58 rocket motor (AIM-7) to detonation of the worst-case adjacent warhead (AIM-120, WDU-33) in an aircraft (F-15) load configuration. (There is a slightly more closely spaced case of this same warhead to motor scenario on an F-16; however, the offset in the axial direction is such that fragment insult to the motor in the F-15 scenario is much greater.) *This testing showed no lateral motor detonations. Physical evidence (ignition and burning of the rocket motors) and pressure data showed no significant motor contribution.*

e. Reference g also reports testing of the worst-case warhead-to-warhead scenario, similar to the earlier AIM-120 testing in an F-16 configuration (see paragraph a above). However, in this case, the donor warheads were WDU-33s (AIM-120) and the acceptor warheads were WDU-41s (AIM-120). There were no acceptor warhead detonations. *This testing showed that where AIM-120 donor warhead fragments can impact AIM-120 acceptor warheads on the same wing, the impacts do not cause sympathetic detonation.*

f. The attachment to reference g shows witness plate evidence of the fragment patterns produced by detonations of the two AIM-120 warheads (WDU-33 and WDU-41) and the two AIM-7 warheads (WAU-17 and WAU-10). Since the warhead positions above the witness plates are known, the patterns yield the angular spread of fragments fore and aft of the warheads.

g. Reference h includes the IHD, NSWC analyses of the hazardous fragment distances associated with WDU-33 and WDU-41 warheads, and the debris assessments for fabric and light metal structures.

The aircraft MCEs were derived from assessments of the geometry of the load configurations, based on scaled drawings, in combination with the preceding conclusions. The possible Noble Eagle aircraft load configurations are presented for reference in tabular format in an EXCEL file accompanying this statement. The rationale associated with the MCEs for the configurations listed in tables 4 and 5 of the attachment to reference a are presented in the following summary:

SUMMARY STATEMENTS OF RATIONALE FOR MCES ASSOCIATED WITH F-16 AND F-15 CONFIGURATIONS

(Keyed to configurations listed in Tables 4 and 5 of Noble Eagle QD Determinations)

WAU-17 and WAU-10 warhead sections are the same length (~16 inches) and span the same stations on the AIM-7 missile. Forward angular fragment pattern of the WAU-17 may be considered contained within 6 degrees forward of the front of the warhead. Aft angular fragment pattern may be considered contained within 3 degrees aft of the rear of the warhead. Fragment pattern of the WAU-10 is highly annular, extending slightly forward of the warhead front, and insignificantly aft of the warhead rear.

WAU-33 and WAU-41 warheads are the same length (~11 inches) and span the same stations on the AIM-120 missile. 12 degrees forward and 4 degrees aft may be considered to contain the pattern from both warheads.

F-16 Configuration 1 (4 AIM-120s, 2 AIM-9s)

- AIM-120 worst-case spacing and orientation is station 1 to station 2. Testing showed no sympathetic detonation. No AIM-120 on an F-16 will propagate detonation directly to another.

- Assume AIM-120 detonation propagates to AIM-9.

- AIM-9P warhead at station 2 is oriented slightly more forward than an AIM-120 warhead at station 2. AIM-9 detonation at station 2 constitutes lower insult to AIM-120 at station 1 than does AIM-120 detonation at station 2. AIM-9 detonation at station 2 is further from and further out of radial alignment with AIM-120 at station 3 than it is with respect to an AIM-120 at station 1. Can conclude AIM-9 detonation will not propagate to an AIM-120.

- For any configuration 1 combination, the MCE does not exceed one AIM-120 and one AIM-9

F-16 Configuration 2 (2 AIM-120s, 2 AIM-9s, and 2 AIM-7s)

- AIM-7 is always on station 3. If AIM-120 is at station 1, the forward station of its warhead is ~17 degrees aft of the aft station of the AIM-7 warhead. That is out of the AIM-7 fragment pattern. Detonation of the AIM-7 warhead may be considered to

propagate to the AIM-9. As in configuration 1, the AIM-9 warhead detonation is not expected to propagate to the AIM-120.

- If the AIM-120 is at station 2, the front of the warhead is ~19 degrees aft of the rear of the AIM-7 warhead. Each warhead is out of the other's fragment pattern. Detonation of AIM-7 may be expected to propagate to the AIM-9. The AIM-9 is not expected to propagate to the AIM-120.

- The MCE does not exceed one AIM-7 and one AIM-9.

F-16 Configuration 3 (2 AIM-120s, 4 AIM-9s)

- MCE is considered to be the missiles on one wing. Testing has shown detonations do not propagate to the opposite wing. MCE does not exceed one AIM-120 and two AIM-9s.

F-16 Configuration 4 (6 AIM-120s)

- Testing of the worst-case spacing and orientation has shown that detonation does not propagate between missiles. The MCE is detonation of one AIM-120.

F-15 Configuration 1 (4 AIM-120s, 2 AIM-9s, and 2 AIM-7s)

CASE 1 – AIM-7s in rear fuselage position:

- Drawing CPF 150107, sheet 3 of 3 typical. AIM-120 on station 2, inner position. Angular offset between rear of fuselage AIM-120 warhead and front of AIM-120 on station 2 is ~22 degrees. Detonation of one AIM-120 will not propagate to the other. AIM-9 constitutes lesser insult to AIM-120 on station 2 than does AIM-120 warhead to AIM-120 warhead in worst case F-16 configuration. AIM-9 does not threaten fuselage AIM-120. Detonation of one AIM-120 is considered to propagate to the AIM-9.

- Similar logic applies when AIM-9 on station 2 is on the inner position. The worst-case AIM-120 to AIM-120 spacing and orientation is not as severe as on the F-16, which does not propagate.

- AIM-7 warhead detonation will not produce fragment impact on other warheads on the same wing.

- MCE is *either* one AIM-7, *or* one AIM-120 and one AIM-9. Either of the two cases could drive QD, depending on warhead type and distance (IB, IL, or IM) of interest.

CASE 2 – AIM-7s in front fuselage position:

- Drawing CPF 1500C1, sheet 3 of 3 typical. Angular offset between AIM-7 and AIM-120 on station 2 is greater than between AIM-120s in Case 1. Similarly, no propagation is expected between AIM-7 and AIM-120, either direction. AIM-9 may detonate.

- MCE is one AIM-7 and one AIM-9.

F-15 Configuration 2 (4 AIM-9s, 4 AIM-7s)

CASE 1 (WAU-17s in front fuselage positions, and any AIM-9Ps)

- Detonation of rear AIM-7 will not cause or be caused by any other detonation. Detonation of front AIM-7 is considered to propagate to both AIM-9Ps.

- MCE is detonation of one AIM-7 and two AIM-9Ps. (WAU-10 in rear fuselage position could drive IBD).

CASE 2 (WAU-10s in front fuselage positions)

- AIM-9s are out of WAU-10 fragment pattern. AIM-9 threat to WAU-10 (which is more robust than AIM-120 warheads) is less than worst case AIM-9 threat to AIM-120 (which is not considered to present a detonation propagation risk).

- MCE is one AIM-7 warhead, whichever type results in greater QD of concern.

CASE 3 (WAU-17s and only AIM-9Ls or Ms)

- Front of outboard station 2 AIM-9 warhead is ~11 degrees behind rear of WAU-17 warhead, and out of WAU-17 warhead fragment pattern.

- MCE is one WAU-17 (Based on NEWQD. Presence of AIM-9s drives 400-foot IBD).

F-15 Configuration 3 (6 AIM-120s, 2 AIM-9s)

- Forward three missiles have same configurations as for F-15 Configuration 1, Case 1.

- MCE is one AIM-120 and one AIM-9.

